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Remarks on this communication were made by the President, Mr. T. T. Bouvé, and Professor N. S. Shaler.

Dr. H. W. Williams showed a new test for astigmatism.

Six hundred and thirtieth Meeting.

March 24, 1871. — ADJOURNED STATED MEETING.

The PRESIDENT in the chair.

The President presented the report of the Committee on Finance.

The Corresponding Secretary read letters from Messrs. Olney, Whittier, Brush, and Kaulbach, accepting membership of the Academy.

It was voted to appropriate the additional sum of $500, to be expended by the Committee of Publication.

It was voted that the annual assessment be raised from five dollars to eight dollars.

Professor B. Peirce made a communication on the recent eclipse, in which he called attention to the indebtedness of the English observers to the plans of the Americans, and their omission of a suitable acknowledgment. His own observations were conducted in Sicily, where he divided his party into five sections, of which two had clear weather. All the observations tended to show the solar nature of the corona.

Remarks on this communication were made by Professor E. C. Pickering.

Six hundred and thirty-first Meeting.

April 11, 1871. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read a letter from Professor Ferdinand Bôcher acknowledging his election into the Academy.

Professor J. P. Cooke presented a report of the Rumford Committee on the cost of publication of the Life and Works of Count Rumford.

Remarks on this report were made by the President, Messrs. Quincy, Lovering, Lyman, J. C. Gray, J. I. Bowditch, and Shaler.

A motion to suspend the publication of the second volume of Count Rumford's Works was laid on the table, and the report was referred back to the Rumford Committee.

Professor Joseph Winlock exhibited some pictures of the eclipse of 1870, and pointed out the resemblance between the photographs of 1869 and of 1870. He also stated that in his recording spectroscope it is not essential that the registering point should be attached to the telescope, but to the part which is moved for pointing on the lines of the spectrum. In Professor Young's spectroscope, in which the prisms move, the registering apparatus is attached to them.

Professor F. H. Storer presented the following paper on the amount of carbonic acid in the air, by Mr. A. H. Pearson.

The following paper contains an account of a large number of examinations of the air of various places for carbonic acid, made in the chemical laboratory of the Massachusetts Institute of Technology, during the spring of 1870, for the State Board of Health of Massachusetts.

They were made chiefly for the purpose of obtaining a general idea of the amounts of carbonic acid in the air of school-houses and other public buildings; but there are also among them quite a number of estimations of carbonic acid in the open air which may be of interest when compared with similar examinations made in other places.*

In these experiments the carbonic acid was determined by Pettenkofer's method. This method consists in exposing a certain quantity of standard baryta water to the action of a known volume of air, and thus removing the carbonic acid as carbonate of barium.

When the baryta water has been exposed to the air for a sufficient length of time, the baryta remaining in solution is estimated with a standard solution of oxalic acid.

The difference between the amounts of oxalic acid required to neutralize a certain quantity of baryta water, before and after the action of the air, represents the carbonate of barium formed, and from this quantity the carbonic acid present in the air is estimated.

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* See Dr. R. Angus Smith, in the Scottish Meteorological Journal, January, 1870; also the Second Annual Report of the Massachusetts State Board of Health, January, 1871.

The baryta water used in this process was prepared by dissolving 7 grms. of hydrate of baryta in one litre of water. The precise strength of this solution, as determined in the manner described below, was such that 1 c. c. of the solution corresponded to 1,087 mgrm. of CO_2. This solution was kept in a glass bottle, to the rubber stopper of which was fitted a tube containing soda-lime, and another tube just large enough to allow the passage of a pipette for drawing the baryta water.

In order to guard against the action of carbonic acid on the baryta water contained in the pipette from the mouth of the person using it, a tube filled with caustic potash was attached to its larger end. The soda-lime apparatus, noticed above, acted in the same capacity as the potash tube toward the carbonic acid in the air of the room.

The solution of oxalic acid was prepared as follows: — A saturated solution of pure oxalic acid in water was made and allowed to crystallize. These crystals were dried between folds of blotting-paper, and for one half-hour over concentrated sulphuric acid. 2.8636 grms. were then weighed out, dissolved in water, and the solution diluted to one litre. 1 c. c. of this solution corresponds to 1 mgrm. of CO_2.

The strength of the baryta water was determined as follows: — 25 c. c. of the baryta solution were transferred to a small flask, and the oxalic-acid solution run in from a Mohr's burette, until a drop of the mixture failed to give the alkaline reaction (a brown ring on delicate turmeric paper).

Repeated trials showed that 23 c. c. of the oxalic-acid solution were required to exactly neutralize 25 c. c. of the baryta water.

Three large glass bottles, with tightly fitting glass stoppers, were used for holding the air, in which the carbonic acid was to be determined. The capacity of each was obtained by filling with water and then measuring the same, by means of a flask holding 1,000 c. c. and a cylinder, graduated to single c. c. In this manner the capacity of bottle No. 1. reduced to 0° C., and 760 m. m. bar. press. was found to be 5824.10 c. c., that of No. 2, 6166,11 c. c., and of No. 3, 6240.57 c. c., an allowance of 50 c. c. being made in the calculation for the baryta water used in the process. Previous to each experiment the bottles were thoroughly cleansed and then dried by passing a current of heated air through them.

The details of a complete analysis are as follows: — Having filled the perfectly dry bottle, by means of a pair of bellows, with the air to be analyzed, 50 c. c. of the baryta water are added, and the interior surface of the bottle kept moistened by turning the same for about half an hour.

At the end of this time the baryta water is poured into a cylinder, the latter tightly corked, and the carbonate of barium allowed to deposit, requiring about fifteen minutes. 25 c. c. of the nearly clear liquid are now transferred to a small flask, and the oxalic acid solution run in from a burette, until a single drop of the mixture fails to give the alkaline reaction on turmeric paper. Taking, for example, the first experiment made on the outer air, it was found that 20.4 c. c. of the oxalic acid solution were required to neutralize 25 c. c. of the baryta water after the action of the air.

The difference between 20.4 c. c. and 23 c. c., the amount required to neutralize 25 c. c. of baryta water before the action of the air, being multiplied by 2, — for 50 c. c. of baryta water were used in the experiment, — we obtain 5.2 c. c., each c. c. of which is equivalent to nearly one mgrm. of carbonic acid, in accordance with the proportion:

$$\begin{array}{cccc} \text{at.wt.} & \text{at.wt.} & \text{wt. of } \bar{O} \text{ in} & \\ \bar{O} & CO_2 & 1 \text{ c. c. of sol.} & \text{wt. of } CO_2. \\ 63 : & 22 = & .0028636 : & .0009998 \end{array}$$

Multiplying this weight of carbonic acid by 5.2 c. c. and reducing the product to volumes in terms of c. c. at the normal temperature and pressure, we obtain 2.637 c. c. of carbonic acid in the volume of air analyzed. Bottle No. 1 having been used, after reducing its volume to the normal temp. and press., we obtain the percentage of carbonic acid by a simple proportion, thus: —

$$5783.26 : 2.637 = 100 : .04560\%.$$

In order to ascertain if the oxalic acid used in these experiments could be depended on for purity, the strength of the baryta water was tested with different solutions of the acid, prepared from crystals which were obtained under various conditions.

I. A solution of oxalic acid in hot water was made and allowed to crystallize. These crystals were dried between sheets of blotting-paper, 2.8636 grms. weighed out, dissolved in water, and the solution made up to a litre. 25 c. c. of the baryta water required 23 c. c. of this solution.

II. A saturated solution of oxalic acid in water was made as above; the crystals obtained were dried between sheets of paper, and a portion of them allowed to remain for one half an hour over sulphuric acid, and another portion for one hour. Solutions were made of these crystals of the same strength as above, and 25 c. c. of baryta water tested with the same results as before.

III. A saturated solution of oxalic acid in hot water was allowed to stand until nearly cold. The crystals thus obtained were rejected and the mother-liquor allowed to stand until another crop of crystals had deposited. These crystals were dried between sheets of paper and for one half an hour over sulphuric acid, a solution made of them, and the baryta water tested in the usual manner with a like result.

IV. A saturated solution of oxalic acid in cold water was allowed to remain over sulphuric acid, under a bell-glass, until a quantity of crystals was deposited. These were rejected and the mother-liquor returned to the bell-glass, and a second crop of crystals obtained, which were dried, pulverized, and a solution made of them. The baryta water was tested with this solution, the result obtained being the same as above.

The conclusion drawn from the above experiments was, that the oxalic acid employed in the regular analyses did not differ from that used in these experiments, where the conditions under which the solutions were obtained would not admit the presence of impurities in the oxalic acid.

The results of these examinations of the air for carbonic acid are as follows: —

I. — *Outer air in Boston.*

Locality.	Per cent. of Carbonic Acid by Volume.	Date. 1870.	Time.	Temperature. Centigrade. Deg.	Barometer. Inches.	Remarks.
Newbury Street, near Institute of Technology,	.04560	Mar. 17	11.00 A. M.	— 3.5	29.330	Cloudy, wind N. W.
	.03194	Apr. 1	8.45 "	9	30.372	Clear, wind N. E.
	.03894	" 1	8.45 "	9	30.372	" "
	.03988	" 8	9.40 "	13	30.134	" "
	.04449	" 8	9.40 "	13	30.134	" "
	.04218	" 8	9.40 "	13	30.134	" "
	.03798	" 13	11.00 "	14	30.000	Clear, wind N.
	.04435	" 13	11.00 "	14	30.000	" "
	.04230	" 14	2.35 P. M.	25	30.016	Clear, wind S W.
	.04292	" 14	2.35 "	25	30.016	" "
	.04999	" 28	2.20 "	28	29.872	Cloudy, wind S. W.
	.04903	" 28	2.20 "	28	29.872	" "
Park St. near Tremont,	.04493	May 3	8.30 "	14	29.936	Clear, wind N.
Newbury Street,	.03394	" 12	2.45 "	22	29.852	After storm; light clouds, wind S. W.
	.03561	" 12	2.45 "	22	29.852	
Public Garden,	.02905	" 17	10.45 A. M.	14	30.170	Cloudy, wind N. E.
	.03563	" 18	4.05 P. M.	22	30.336	Clear, wind S. W.
	.02969	" 19	10.50 A. M.	25	30.244	" "
	.02586	" 30	3.40 P. M.	20	30.264	Clear, wind S. E.
Cupola of State House,	.03139	" 18	3.15 "	20.5	30.336	Clear, wind S. W.
Clarendon Place, near Berkeley Street,	.03371	" 19	1.30 "	28	30.212	" "

II. — *Rooms at the Massachusetts Institute of Technology.*

Locality.	Percent. of Carbonic Acid by Volume.	Date. 1870.	Time.	Temperature. Centigrade.	Barometer. Inches.	Remarks.
				Deg.		
Small " weighing room," Laboratory Inst. Tech.,	.13205	Mar. 15	3.00 P. M.	22	30.190	
	.13041	" 15	3.00 "	22	30.190	
Drawing-room of second year's class, Institute Technology,	.08836	" 16	9.40 A. M.	14	29.760	Wind N. E.
	.08416	" 16	9.40 "	14	29.760	" "
	.05693	" 16	5.00 P. M.	15	29.760	" "
	.05551	" 16	5.00 "	15	29.760	" "
Room 11 after recitation, Institute Technology,	.09762	" 17	1.15 "	21	29.330	
	.08929	" 17	1.15 "	21	29.330	

III. — *Air of School-Rooms in Boston.*

Locality.	Percent. of Carbonic Acid by Volume.	Date. 1870.	Time.	Temperature. Centigrade.	Barometer. Inches.	Remarks.
GRAMMAR SCHOOLS.				Deg.		
Myrtle Street,	.13431	Mar. 24	10.25 A. M.	23	30.200	
	.13659	" 24	10.30 "	23	30.200	
Dartmouth "	.12912	" 25	10.30 "	18	30.430	
Hawkins "	.09748	" 29	10.20 "	21	29.906	
Tremont "	.14335	" 29	3.00 P. M.	23	29.950	
Waltham "	.12111	" 29	3.30 "	18	29.950	
Common "	.17686	" 30	10.05 A. M.	18	30.260	
West Springfield "	.10164	" 31	10.25 "	21	30.396	
Blossom "	.19037	April 5	10.30 "	22	29.900	
North Bennet "	.17887	" 6	10.15 "	18	29.920	
Richmond "	.17781	" 11	10.10 "	20	30.196	
Anderson "	.08570	" 12	10.10 "	23	29.648	
Northampton "	.18622	" 18	10.10 "	22	29.982	
Tyler "	.12586	" 18	3.35 P. M.	20	29.850	
South "	.17598	May 10	10.15 A. M.	23	30.114	
PRIMARY SCHOOLS.						
Appleton Street,	.11092	Mar. 25	3.15 P. M.	20	30.460	
Hanover (Station House),	.14296	" 28	10.30 A. M.	20	29.556	
110 Merrimack Street,	.18187	" 28	11.15 "	20	29.556	
Poplar "	.11173	April 5	11.15 "	20	29.900	
North Bennet "	.16824	" 6	10.25 "	20	29.920	
Richmond "	.08101	" 11	10.20 "	22	30.196	
Phillips "	.08971	" 12	10.20 "	22	29.648	
West Concord "	.13999	" 18	10.25 "	21.5	29.982	
Tyler "	.11015	" 18	3.50 P. M.	19	29.850	
Newbern Place,	.15541	" 19	11.35 A. M.	23	29.796	
Warrenton Street,	.14575	" 19	11.50 "	22	29.796	
Suffolk "	.10618	" 19	3.35 P. M.	22.5	29.750	
Cooper "	.19927	" 21	9.55 A. M.	22	29.888	
Thacher "	.17292	" 21	10.10 "	23	29.888	
Sheafe "	.18692	" 21	3.40 P. M.	22.5	29.856	
Snelling Place,	.16056	" 21	3.55 "	19	29 856	
Genesee Street,	.16082	" 22	9.50 A. M.	23	30.050	
Way "	.12284	" 22	10.15 "	23	30.050	
Groton "	.14507	" 25	11.20 "	20	30.092	
Rutland "	.11663	" 25	11.45 "	22	30.092	
Hudson "	.13024	May 9	3.40 P. M.	18	29.856	
Common "	.07732	" 9	3.55 "	18	29.856	
East "	.16988	" 10	10.05 A. M.	22.5	30.114	
Chardon "	.09934	" 11	10.15 "	22.5	30.034	
Blossom "	.12708	" 11	10.50 "	21	30.034	

IV. — *Air of Halls, etc., in Boston.*

Locality.	Percent. of Carbonic Acid by Volume.	Date. 1870.	Time.	Temperature. Centigrade. Deg.	Barometer. Inches.	Remarks.
Music Hall, Tremont St.,	.14045	May 4	4.05 P. M.	25	29.576	
Low tenement house, known as the "Crystal Palace," Lincoln St.,	.09530	" 17	2.30 "	23	30.242	
Open air in rear of above,	.03976	" 17	2.50 "	15	30.242	
Hall of Y. M. C. U., 300 Washington Street,	.15239	Apr. 27	9.05 "	26	30.060	
Municipal Court Room, Court Street,	.12047	" 20	1.30 "	23	29.784	
Office of Secretary of State, State House,	.08914	Mar. 22	2.45 "	24	29.892	
Printing office, 79 Milk St.,	.16183	Apr. 4	3.30 "	20	29.724	
Globe Theatre,	.14438	" 11	9.00 "	23	29.952	
St. Paul's Church,	.05929	" 15	11.00 A. M.	21	30.292	
Public Library, waiting-room,	.13666	Mar. 19	2,30 P. M.	20	30.150	
	.13747	" 19	3.45 "	21.5	30.150	
	.19352	Apr. 20	7.50 "	23	29.784	

Six hundred and thirty-second Meeting.

May 9, 1871. — MONTHLY MEETING.

The PRESIDENT in the chair.

The following Annual Report of the Council was read by the Corresponding Secretary.

Since the last report of the Council the following gentlemen have been elected members of the Academy: —

Charles C. Perkins, of Boston, to be a Resident Fellow in Class III., Section 4.

Nathaniel Holmes, of Cambridge, to be a Resident Fellow in Class III., Section 1.

Raphael Pumpelly, of Cambridge, to be a Resident Fellow in Class II., Section 1.

George Derby, of Boston, to be a Resident Fellow in Class II., Section 3.

E. J. Cutler, of Cambridge, to be a Resident Fellow in Class III., Section 2.

E. J. Young, of Cambridge, to be a Resident Fellow in Class III., Section 2.

C. C. Langdell, of Cambridge, to be a Resident Fellow in Class III., Section 1.